

positioned in an array of rows and columns although often configuring are possible. Any number of electrodes may be used.

[0113] Elastomer layer 340 includes one or more elastic members 341 positioned between the electrode layer 338 and the conductive layer 342. Elastic members 341 allow the display 332 to move inwardly with a limited amount of displacement. In one implementation, elastic members 441 are silicone patches with a thickness of about 0.2 mm.

[0114] Conductive layer 342 typically takes the form of a grounded metal plate 343. A capacitive circuit is formed between each of the electrodes 339 and the grounded metal plate 343. When a user pushes down on the display 332, the force being exerted thereon causes the display 332 to displace inwardly against the elastic members 341 compressing the elastic members. This causes a change in the capacitance between the electrodes 339 and the metal plate 343. This change in capacitance is sensed by a control circuit operatively coupled to each of the electrodes 339. Capacitance sensing circuits are disclosed in the various incorporated references.

[0115] FIG. 22 is a side elevation view of an input device 350 that may be positioned over a display. The input device 350 combines touch sensing and force sensing into a single device. In this embodiment, both the touch sensing and force sensing is provided by mutual capacitance. As shown, the input device 350 is formed from various layers including a top drive layer 352, a middle sense layer 354, and a bottom drive layer 356. Furthermore, the middle sense layer 354 is positioned on an elastomer layer 358 disposed between the middle sense layer 354 and the bottom drive layer 356. The top and bottom drive layers 353 and 356 include a plurality of spatially separated lines in rows and the middle sense layer 354 includes a plurality of spatially separated lines in columns. The top and middle layers 352 and 354 therefore form a grid, and the bottom and middle layers 356 and 354 form a grid.

[0116] During operation, the lines on the top layer 352 are scanned, and thereafter the lines on the bottom layer 356 are scanned (or vice versa). When there is a touch, the mutual capacitance measured between the top drive layer 352 and the middle sense layer 354 provide the x and y location of the touch. In addition, the mutual capacitance measured between the bottom drive layer 356 and the middle sense layer 354 provide the amount of force of the touch. This particular arrangement provides a full image of force superimposed on a full image of touch. The input device including the touch layers and the force layers may be operated similarly to the methods described in U.S. patent application Ser. No. 10/840,862, titled "Multipoint Touch Screen," filed on May 6, 2004.

## 2. Force Sensitive Housing

[0117] The hand-held device may also include a force sensitive housing. The force sensitive housing provides inputs when forces are applied to the housing of the hand-held device. A force sensitive housing is similar to a force sensitive screen in that. The housing provides a slight amount of flex (possibly unnoticeable to the user) so that any forces exerted thereon can be distributed to a force detection arrangement located within the housing. The force detection arrangement monitors the forces on the housing and pro-

duces signals indicative thereof. As with the force sensitive display discussed above, the force detection mechanism may include one or more force sensors disposed within the housing such as force sensitive resistors, force sensitive capacitors, load cells, pressure plates, piezoelectric transducers, strain gauges and/or the like. When a force is applied to the housing (squeezing or pushing on the housing), it is transmitted through the housing to the force sensor located within the housing.

[0118] The force sensitive portions of the housing may be located on any surface of the housing, any side of the housing, any portion of any side of the housing or at dedicated locations on the surface of the housing. The sides of the housing are ideal places for implementing a squeeze feature. This is because the users fingers are typically positioned on one side of the device and thumb on the other and therefore the hand may easily squeeze the sides via a pinching action. Because it is so convenient to activate the squeeze feature, special care must be taken when designing the squeeze feature so that it will not be accidentally activated during normal use. Thus the device needs to be able to differentiate between light and hard squeezes. If the squeeze feature is implemented using force sensitive resistors (FSRs) which exhibit a decrease in resistance with an increase in force applied to the active surface a comparator circuit can be used to output a signal to indicate activation when a preset force threshold is reached.

[0119] FIG. 23 is a side view, in cross section, of a hand-held device 370 that incorporates a squeeze feature. As shown, the device 370 includes a housing 372 and a support platform 374 inside the housing 372. Between the support platform 374 and the inner surface of the housing 372 are a pair of force sensors 376. When a force is applied to the housing 372 as for example by the pinching nature of the hand, the housing 372 flexes inwardly under the pressure. This causes the force sensors 376 to be sandwiched between the housing 372 and the support platform 374. The force sensors 376 measure the amount of force being exerted and when a desired force threshold is reached, the force sensors 376 generate a control signal. For example, as a result of being sandwiched, a force sensitive sensor may exhibit a reduced resistance and when a desired threshold is reached, a control signal is generated.

[0120] The force sensitive housing may be provided in conjunction with a touch sensitive housing as discussed above.

## E. Motion Actuated Input Device

[0121] The hand-held electronic device may also include a motion actuated input device. The motion actuated input device provides inputs when the hand-held device is in motion or is placed in a certain orientation. A motion actuated input device typically includes a motion sensor, such as an accelerometer, that monitors the motion of the device along the x, y, and/or z axis and produces signals indicative thereof. The motion sensor may, for example, include an accelerometer. Alternatively, the motion sensor could be an orientation sensor, such as an electronic compass, that allows the device to determine its orientation in a generally horizontal plane. The motion sensors may be attached to the housing or to some other structural component located within the housing of the device. When motion